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# WOODCOCK HABITAT MANIPULATION AT MOOSEHORN NATIONAL WILDLIFE REFUGE CALAIS, MAINE

Eldon R. Clark

Bureau of Sport Fisheries and Wildlife

Office of Migratory Bird Management

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## INTRODUCTION

The American woodcock (Philohela minor) has been a prized game bird in eastern North America since the basic craft of meat hunting evolved into the beginnings of sport hunting as it is known today. Until recently, woodcock hunting was regarded as a specialty sport with relatively few participants. This was partly because a trained bird dog is essential for maximum enjoyment of the activity. Relatively few hunters knew the deep satisfaction of training and working a good bird dog. Some lacked the time and/or the financial means for bird dog training and hunting. For a decade the sport has increased in popularity.

The American woodcock is a migratory bird, with greatest breeding concentrations between the 40th and 48th parallels of latitude and east of 95 degrees west longitude. Primary wintering grounds are in a 200-mile wide coastal strip extending from eastern Texas to southern Virginia, but excluding south Florida.

Although the facts are not well documented, the literature suggests that market hunting had materially reduced the woodcock population at the turn of the century. There is some evidence that severe weather conditions have depleted woodcock numbers on several occasions in this century.

When the Federal Government assumed the responsibility for migratory birds in the United States with the consummation of the Migratory Bird Treaty Act, an early step toward better management was the establishment of Migratory Bird Refuges (later called National Wildlife Refuges). This activity was conducted by the Bureau of Biological Survey, Department of Agriculture, the forerunner of our present Bureau of Sport Fisheries and Wildlife, Department of the Interior.

Concern for declining waterfowl populations, following prolonged drouth conditions, provided the impetus for great expansion of the refuge system in the mid-1930's. The concern included other migratory birds, especially those in the shorebird family (Scolopacidae), and one area, Moosehorn Migratory Bird Refuge, was established for woodcock.

The Secretary of Agriculture's letter to the President (early 1937), transmitting the proposed draft of the Executive Order establishing Moosehorn Migratory Bird Refuge, contains the following:

> The wildlife population of that region is quite varied. There are numerous ruffed grouse, deer, bear, caribou, and moose, and, during migration periods especially, an appreciable number of the more important species of waterfowl, all of which have in the past been hunted with little regard for law.
>
> The protection of the woodcock, however, is the paramount purpose for the establishment of the refuge.

The Refuge was established by Executive Order No. 7650 dated July 1, 1937. A report by Walter P. Schaefer, the first refuge manager, date-stamped at the Regional Office on December 5, 1939, begins as follows:

> A few years ago it became apparent that the woodcock population was diminishing rapidly and that unless measures were taken for its preservation, it would join the passenger pigeon in extinction. Besides reducing bag and possession limits, the U.S. Biological Survey set out to establish a sanctuary where the bird would be protected and where ideal breeding conditions could be developed.
>
> After careful consideration of the woodcock's breeding range, major flyway routes and available locations, an area near Calais, Maine, was decided upon and acquisition work begun. At the same time a research program, under the direction of the Wildlife Unit of the University of Maine, was set up and the process of gathering further data on the life history of the woodcock was initiated on a part of the proposed area, as well as on a Resettlement Administration area located some 20 miles south.

Throughout the history of Moosehorn Refuge there have been efforts to promote woodcock habitat on as much of the land as possible. Work has centered upon removing forest cover which is too old to be attractive to woodcock, and encouraging development of the young hardwood[1/], alder and mixed stands preferred by this bird. Collateral studies have been conducted on factors influencing habitat and the bird itself. This report summarizes results of both efforts from the time the Refuge was established through 1970. Throughout the report reference to good or poor woodcock habitat, unless otherwise stated, represents evaluations based upon over 20 years of personal experience of working with this species and its habitat.

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1/ See Appendix for list of tree and shrub species with scientific names.

## PROCEDURES AND RESULTS

Habitat manipulation at Moosehorn may well be divided into two periods: (1) Pre-1950, when most of the activity was carried out by public works, and (2) post-1950, when work was done through refuge appropriations. Due to the variety of activities and overlapping time intervals, procedures and results of each activity are discussed jointly. This also provides better continuity to the report.

### A. Pre-1950 Activities

1. Early work by Resettlement Administration.--The earliest work of which any record could be found was the creation of 11 artificial singing grounds on the Edmunds Unit of the Refuge under the direction of Howard L. Mendall. Appendix table 1 shows the location, size, date of cutting, and cover type of those plots. The following paragraph from Mendall and Aldous (1943) recounts the pertinent facts concerning the project:

> Artificial Singing Grounds.--The creation of artificial singing grounds was the first real management step attempted during the Maine studies and its value was clearly demonstrated. As was pointed out in a publication by Aldous (1938), during the late winter and early spring of 1937, eleven clearings were made in second growth woodland by the Farm Security Administration (then known as the Resettlement Administration) on what is now the Edmunds extension of the Moosehorn National Wildlife Refuge. The particular area utilized was made up of a rather solid tract of second growth woodland with few natural openings. Previous surveys had indicated that this land provided

> excellent woodcock flight covers but the lack of openings was believed to constitute a serious limiting factor as far as breeding populations were concerned. Artificial singing grounds were created under a variety of such physical characteristics as size (which ranged from a clearing 60 x 100 feet to one which was nearly an acre in extent), slope, elevation, distance from water, and exposure; this was done to see what preferences if any would be exhibited by the birds. The growth was clear-cut, and the brush piled and burned within the clearing. These clearings were completed too late to permit their use in 1937, as the birds had already selected their singing grounds at that time. In 1938, nine of the artificial singing grounds were checked on two or more nights during the courtship season, and five were found to be in regular use. From 1939 through 1941, all eleven grounds were checked several times, and ten out of the eleven have been used in at least one of the four years available; at least six were used for three years and at least five during four seasons. In the fall of 1938, three more small experimental clearings were made at Edmunds, and two of these were in regular usage the following spring.

The authors quoted above devote one paragraph to thinning of woodcock covers. Since their discussion is concerned primarily with work performed at the Edmunds Unit of Moosehorn National Wildlife Refuge, that paragraph is reproduced here:

> Thinning of Covers.--The thinning of over-mature woodcock covers, or even young, vigorously growing covers, is a management step that seems to offer promise of improving local habitats for the species. As far as conditions in the northeast go, this is chiefly desirable only in certain covers that are primarily of brushland, alder, or alder-willow types. The so-called 'waste species' mature rapidly,

often decaying or dying at early ages. Furthermore, when growing under favorable conditions they frequently form growths too thick for nesting or even feeding covers, and consequently would seldom be used, except during the molting season. It is difficult to describe a growth that is 'too thick', but experience will quickly serve as a guide. Plate 14 illustrates a cover that is too dense and that has reached maturity. Thinning not only opens the cover immediately but encourages new sprout growth to replace the dying plants. Thus in any event the life of such covers can be prolonged. This type of management has been conducted on a small scale at both the Moosehorn and Edmunds units in Maine, although in only one instance was this done prior to 1940. In this case, thinning was conducted in a small cover (about six acres) that consisted of alder, primarily, and in 1936 was in a condition similar to that shown in Plate 14. Repeated censuses by the drive method, conducted throughout the fall of 1936, showed only slight usage by migrating woodcock. Later that winter the decadent growth and a little of the living growth were removed. Also the cover was subjected to a light burn. Careful checks in the breeding season of 1937, however, showed no nesting birds, although in the fall, on two occasions, a number of migrating birds were found in the cover. Late in the fall (1937), all of the remaining alder was subjected to approximately a 25% thinning. During the breeding season of 1938, no nest-hunting crews were available on the Edmunds unit, but a check in the fall indicated a continued increase in the number of migrating birds frequenting the cover; and in the spring of 1939 two nests were found there.

2. Strip cuttings.--The second refuge manager at Moosehorn, Bertrand E. Smith, conceived the idea of creating woodcock habitat by clear-cutting strips through stands of timber which had passed the optimum woodcock cover stage. This plan involved clear-cutting entire valleys over an 8-year rotation period. To do this it was proposed to divide

the valley into strips two chains wide extending from the top of the ridge on one side of the valley to the top of the ridge on the other side. Mr. Smith believed that somewhere between the top of the ridge and the floor of the valley would be found optimum conditions of soil moisture and cover density at any particular time of the year. His idea was that woodcock would use the ridge tops during wet periods, the valley floor during dry periods, and intermediate area during all except dry periods.

Since good woodcock cover usually retains its value as such for a comparatively short period of time, it would be necessary to keep some cover in each stage of development at all times; some cutting must be done each year. An arbitrary rotation period of 8 years was established for the main Moosehorn valley. Under that system every eighth strip was to be cut the first year, the adjoining strips on the south cut the second year, and the process repeated until the entire valley had been clear-cut. The area would then be kept under close observation for a period of years to determine when the cutting cycle should be repeated as well as to learn of any desirable changes in procedures.

As a variation of the above, each strip was divided into blocks five chains long by two chains wide. On each strip that was to be cut, every other block was cleared. Since only half as much area would be covered by this method, alternating blocks on two contiguous strips were cut, producing a checkerboard effect. A third cutting plan was similar to

that just described except that the blocks were two chains square (0.4 acre) instead of 2 x 5 chains (1.0 acre) in size. Since the smaller blocks produce the greatest edge area, which is beneficial to all wildlife, it was considered the best of the three and was the method most extensively used.

The strip cuttings were initiated on Moosehorn valley in March 1940. By the end of May, all first-year cutting planned for Moosehorn and Mahar valleys had been completed. Acreage cleared under this plan in the spring of 1940 totaled 102.4 acres. In the winter of 1940-41 the second-year cutting was accomplished on Moosehorn and Mahar valleys, and the project was extended to Barn Meadow valley. Blocks cleared that year totaled 143.8 acres for a 2-year total of 246.2 acres treated by this method.

Personnel of the National Youth Administration (NYA) camp on the refuge laid out the strips and designated areas to be cut. Crews from a nearby Civilian Conservation Corp (CCC) camp did the strip cutting, including piling and burning the slash. When these two camps were discontinued in the summer of 1941, it was necessary to abandon the strip-cutting plan for lack of funds and personnel.

3. Other cuttings by CCC.--The need for singing grounds to be used by male woodcock during the breeding season has long been recognized. Upon the recommendation of Messrs. Howard E. Mendall and Clarence M.

Aldous of the Maine Cooperative Wildlife Research Unit, 37 artificial singing grounds were cut in January and February of 1940. All but six of these were on the Edmunds unit since it was thought that the strip cuttings would answer the need for singing grounds over much of the primary unit. Also, there were more natural openings suitable for singing grounds on that unit. The artificial singing grounds varied in size from 0.15 to 1.94 acres but the great majority were between 0.25 and 0.50 acres. The larger areas had a slight advantage in that they were not so quickly lost to encroaching marginal vegetation. Information on these plots is summarized in Appendix tables 2 and 3.

A total of 16.71 acres was cleared in the process of constructing these singing grounds. The work was accomplished by CCC labor and included piling and burning the slash. In addition, 5,465 rods of 8-foot trail were cut to provide access to these singing grounds. Nearly all of these singing grounds were used. Hardwood sprouts were largely eliminated by deer browsing and conifers grew slowly. Therefore, the openings persisted and were used by woodcock for many years. Many were still in use as singing grounds 25 years after cutting. The covers in which they were located retained their usefulness much longer than similar covers in which there were no singing grounds.

The CCC crews also made several large clearings in the fire subclimax birch-aspen-spruce-balsam type at Edmunds from the fall of 1939 to the spring of 1941. Much of that cover had passed its prime as woodcock habitat; the clearings were made in an effort to set back type succession to approximate conditions 25 years earlier. A total of eight clearings containing 67.9 acres were cut in this manner. The slash was piled and burned as in all CCC cuttings. Included with these cuttings in Appendix table 4 is a cutting made by WPA under the Resettlement Administration in the spring of 1937. Although the clearing was made for a gravel pit, it is similar to the CCC cuttings in all respects and the pit occupies a very small part of the clearing.

Luxuriant growths of sprouts were produced but after 3 years few of them remained and the areas resembled grassy meadows. The heavy sod which developed retarded volunteer conifer growth. Consequently, upland sections of these clearings have changed little in 32 years. Alder is well developed on low moist sections. These openings all serve as singing grounds, some providing multiple sites, but their greatest value, as recently discovered, is for night roosting by woodcock (see section A-6 below).

4. Cover improvement through sale of stumpage.--The sale of wood stumpage on the Refuge serves the dual purpose of providing income and removing undesirable growth from potential woodcock covers. A total

of 309.8 acres--251.0 on the primary unit and 58.8 at Edmunds--have been cleared by that means. The greater part of it was in spruce-balsam stands too mature to be of any value as woodcock cover. The remainder was in fire subclimax type, with gray birch, white birch, aspen, and red maple the dominant species. These stands, too, were past their prime as woodcock covers when they were cut. The understory spruce and balsam were becoming more prominent and the stands were gradually reverting to those climax species.

Slash disposal procedures on these areas varied greatly. On some of the earlier cuttings the NYA crew was used to pile and burn the material. On some areas it was left lying in windrows and fire was run over the area when burning conditions were right. That sometimes produced a clean burn but often varying amounts of slash were left. On some areas, especially those cut during the late 1940's, no attempt was made to dispose of the slash. Tables 7 and 8 list the stumpage areas cut with the acreage, dominant species, date, and slash disposal on each. Results are discussed following section 5 below.

5. Cuttings by Refuge personnel.--Several areas have been clear-cut by Refuge personnel. The primary purpose was to obtain fuelwood for headquarters buildings and for the recreation area at Edmunds. However, some of the best woodcock cover on the Refuge has resulted from these cuttings. Total area covered was 36.4 acres, of which 16.0 acres was on the Edmunds unit. Fourteen acres at Edmunds were primarily

of the spruce, balsam, and cedar type, which leaves very heavy slash. Ten acres was broadcast-burned with practically all slash consumed; the material on the other four acres of that type was left as it fell. The remaining two acres at Edmunds and all cutting on the primary unit at Baring was in hardwood stands. Since hardwood slash decays quickly and is not detrimental to development of woodcock cover, no slash disposal was required for that type. A summary of the cutting by refuge personnel, with the pertinent data on each, is shown in table 9.

The only systematic evaluation of the early cuttings at Moosehorn was conducted from the fall of 1948 through the spring of 1950 by Jim D. Rearden, a wildlife graduate student at the University of Maine (Rearden, 1950). The study included the determination of cover preferences and the relationship of improved covers to actual usage by woodcock throughout its seasonal tenancy in Maine. A trained bird dog was used to search covers for woodcock at various seasons. The basis of the evaluation was the number of woodcock flushed and the number of woodcock sign observed. Following are Mr. Rearden's conclusions:

> (1) In the breeding season (April 15 to July 15) the preferred type was hardwood, with alder as second choice. In the summer (July 15 to September 15) preferred type was alder, with hardwood as next choice. During early fall (September 15 to October 15) preferred covers were pure alder, with hardwood and mixed hardwood and softwood as second choices. In late fall preference was more strongly for alder than in any previous season, with hardwood a poor second choice by the birds.

(2) A preference for the usage of the improved covers was exhibited by woodcock. Male birds utilized the openings of the developed covers extensively for singing grounds, and young woodcock were found to use the managed areas much more extensively than the nearby unimproved cover. During the molting period of summer when woodcock are difficult to find, the only birds that could be located on the refuge were in the developed areas. Heavy usage was also made of these covers during the fall months.

(3) It seems apparent that the strip cuttings in the Moosehorn and Mahar valleys have been much more effective than either the stumpage cuttings or strip cuttings in upland dry areas. Since there still remain many undeveloped lowland and intermediate covers on the refuge, it would appear advisable that such areas within the refuge be given preference in the future woodcock management program.

6. Controlled burning.--Although considerable area has been burned in disposing of slash, it was not until the spring of 1949 that an area was burned without first being cut. This area, containing 6.7 acres, is located in a young gray birch stand near the primary unit headquarters. This stand was used as nesting cover and to a lesser extent in the fall. However, the trees were too tall and crown cover too sparse to serve as summer cover. It was hoped that spring burning when the ground was wet would kill the tree growth but would leave the root systems to produce sprouts. The area was burned on May 5 with a light wind carrying the fire through dead grass, leaves, and other litter. A triple fire line constructed around the area with a tractor-drawn brush plow effectively prevented the fire from spreading outside the planned burn area. The burn did not have the desired effect in that root systems as well as tree trunks were killed. There was no regrowth and, in a few years, when the dead trunks fell, the burned area became a clearing.

In the spring of 1950 a second area of approximately 10 acres near the 1949 burn was treated in the same way with similar results.

The burned areas have been used as singing grounds each year. However, their true value was not learned until 1962 when Fant Martin, the Bureau's Migratory Bird Populations Station's woodcock biologist, visited Moosehorn to investigate methods of capturing woodcock for banding. He found that substantial numbers of woodcock gathered on these clearings at night. Cover in the clearings was primarily lowbush blueberry and sweetfern, with some sedge, milkweed, and bracken fern. Interspersed small openings (a few square inches) in this cover seemed to provide conditions desired by woodcock for night use. These fields became the center of Martin's banding activities and they have continued through the present as the most productive areas on the Refuge for mist-netting and night-lighting woodcock. To maintain their productivity, the clearings have been burned at about 5-year intervals since the mid-1960's.

7. Miscellaneous projects.--A number of small projects aimed at improving conditions for woodcock have been undertaken on the Refuge. These were mainly of an experimental nature. For various reasons, chiefly lack of personnel, conclusive results were not obtained on any of these. Following is a brief discussion of the more important of the projects:

(a) Soil sampling and earthworm counts.--The NYA crew spent considerable time in 1940 collecting soil samples and making earthworm

counts on both units of the Refuge. This work was under the direction of the Maine Cooperative Wildlife Research Unit and Moosehorn Refuge personnel. Mendall and Aldous report on this work in their 1943 publication, and excerpts from that bulletin follow:

> .....over 600 soil samples and earthworm counts were taken in various cover types..... Insufficient samples have been taken to draw suitable correlations, and more elapsed time is needed to obtain satisfactory data on the changes in cover, soils, or in earthworm abundance that result from environmental manipulation.
>
> In general the largest number of earthworms have been found in soils having a hydrogen ion concentration (pH) of between 5.00 and 5.75 although they were found quite commonly in soils as acid as 4.75 or when the pH was as high as 6.00.....
>
> .....At present the Maine studies indicate that eight or more earthworms per cubic foot of soil might well be considered as affording at least reasonably good feeding for woodcock..... As many as 26 earthworms have been found in a cubic foot sample taken in an Alder cover..... In general, the more extensively a cover consists of conifers,--especially tamarack, or black spruce,--the more acid the soil becomes and fewer the earthworms found.

After the NYA establishment was discontinued, no further soil sampling or earthworm counts were made. The refuge allotment of funds and labor were inadequate to carry on this work.

(b) Mahar valley experimental cuttings.--Under the direction of Refuge Manager Smith the CCC established a one-acre experimental block in Mahar valley. The object of this experiment was to determine whether the month of the year in which a cutting was performed had any effect on the success of sprout growth establishment. The area was marked off with

posts and single wire and divided into four parts. One part was to be cut in each of the months of June, July, August, and September. Before this project could be completed, the CCC program was discontinued and again the Refuge was unable to continue the experiment.

(c) Alder seed planting.--Late in 1946 a small area of meadowland on Moosehorn Stream was plowed and alder seed were broadcast over the area. This was an attempt to make good woodcock cover of an area which was supporting nothing but a dense stand of grass and sedge. However, plowing exposed little except bare clay--a very poor seed bed. When this area was examined in the summer of 1947, the clay had baked hard and no alder seedlings could be found. The same condition was found when the area was reexamined in 1948.

(d) Experimental blueberry plots.--The blueberry plot work is well described by Jay S. Gashwiler in his report of November 16, 1943, titled Experimental Blueberry Work at the Moosehorn National Wildlife Refuge, Milltown, Maine, Fall, 1943. A summary of his report and of work performed subsequent to that date is given here:

> In this section of Maine, large acreages are devoted to the culture of blueberries. To keep the crop of berries at its peak and to keep the barrens in condition they are burned over every second or third year. This burning is done in the spring as soon as conditions are dry enough--a period which coincides with the early nesting of woodcock. Since the birds often nest

in or near the edge of these blueberry barrens, many nests are destroyed each year. It was believed that fall burning would produce the same beneficial results for blueberries and eliminate this source of nest losses in the spring. In an attempt to study this alternative procedure, a series of one-acre plots were established at Edmunds on formerly good blueberry land. Three sets of two plots each were established—one to be burned in the spring and one to be burned in the fall of each year. Presupposing a 3-year rotation, the three pairs of plots would complete the cycle. Beginning in the fall of 1943 the plots were cut and burned on schedule up to and including the spring of 1946. This resulted in one burn for each plot--two burns were considered necessary to bring these areas back to full production. In the fall of 1946, scheduled burning could not be completed because of frequent heavy rains. In view of this, the corresponding plot was not burned the following spring. Fields and woodlands were explosively dry during the falls of 1947 and 1948; burning was not attempted because of the high fire risk. Because fall weather conditions proved so uncertain, the fall burning idea was abandoned.

(e) Forest study plots.--Plant succession and rate of growth following cuttings are extremely important factors to consider in planning cover improvement through cutting. In order to obtain information

concerning these matters a series of sample plots embodying various cutting practices in different cover types were established. Studies on these plots were initiated over the period from 1941 to 1944, with individual plots being checked every summer through 1945. Plots established in 1944 were checked in 1946 and all plots were rechecked in 1948, 1950, and 1954. Following is a summary of the results of those checks:

(1) Clear-cutting on a 28-year-old quaking aspen stand on a moist gentle slope with fair soil resulted in a fine stand of aspen and alder reproduction. Nine years after the cutting this stand was being used by woodcock; 6 years later it still was excellent cover. At 15 years of age, conifers were appearing in numbers but were not expected to become a significant part of the stand for several years. The check plot (uncut) in this type showed some utilization by woodcock when the cover was 37 years of age; subsequently, balsam fir began to dominate the stand and no further usage was noted except at its atypical northern edge.

(2) Clear-cutting in a 46-year old balsam fir stand on a rather dry gentle slope with fair soil failed to produce a satisfactory stand of reproduction. The desirable deciduous sprout growth which followed the cutting was browsed to near extinction by a large deer herd; 15 years after treatment, the area was a grassy

meadow with interspersed patches of sweet fern. At the latest check (1954) the water table on the low side of the plot had been raised by a beaver flowage and a good stand of alders was established. The balance of the plot seemed destined to be taken over by coniferous growth.

Little change occurred in the check plot until 1950 when the over-mature balsam trees were dying rapidly. Sun-scald and wind-throw took a heavy toll in the exposed southeast corner of this plot and material changes were evident. As mature trees fell, opening the canopy, a dense cover of balsam reproduction appeared.

(3) A 28-year-old stand of balsam fir with scattered gray birches on a steep, rather dry slope produced excellent hardwood sprout growth after clear-cutting. After 2 years of heavy deer browsing, little of this growth remained and this plot resembled the other clear-cut balsam plot. However, the original stand and surrounding area contained more seed-producing gray birch than the older stand. In 1954, a moderate stand of gray birch seedlings had become established. The slower growing seedlings were not as attractive to deer as fast-growing succulent sprout growth. The seedlings persisted longer than the sprouts but were

never able to establish a closed canopy overstory suitable for woodcock cover. The check plot of this pair was similar to the other balsam check plot except, being younger, there was less deterioration of the crown cover.

(4) Clear-cutting in alder stands produced generally good results. In a 15-year-old stand on a flat, moist flood plain, regeneration of the species was excellent and good woodcock cover was produced in 5 to 8 years. At 14 years of age this stand still was fine woodcock cover. The check plot on this site regenerated itself every 4 to 7 years without treatment. However, it did not reach the optimum conditions present on the clear-cut plot.

(5) A 16-year-old stand of alder on a higher elevation than that described in the previous paragraph produced spotty reproduction after clear-cutting. Meadowsweet, raspberry, and grasses still dominated some sections of this plot 11 years after it was cut. However, a good stand of alder and choke cherry was produced on part of the plot. Some of this reached woodcock cover size and density in 5 years. Conifers eventually dominated the plot but their rise in prominence was slowed by the cutting. The untreated check plot changed to coniferous growth more rapidly, and by 1954 was of little value for woodcock cover.

(6) A third set of alder plots, comprised of two experimental plots with one check plot, were established in 1944 in a 13-year-old stand along a stream. On one experimental plot, all crown cover alder and all stems of other species except choke cherry were cut in the spring of 1945. The slash was removed from the plot. One year after the cutting, the younger alders reached crown cover size and were forming excellent cover. However, a heavy infestation of alder leaf beetles defoliated much of the alder. Choke cherry, which had become the dominant species in the understory, increased percentagewise in the stand by 1950. Generally speaking, the combination of alder and choke cherry was on the verge of good woodcock habitat in 1950.

Treatment of the second experimental plot was similar to that of the first except that slash was lopped and scattered on the plot instead of being removed. About one-third of the crown cover was removed, including decadent alders and all other tall species. Changes in contour elevation of 1 to 2 feet seemed to influence the regeneration of alder. On higher ground, alder was interspersed with openings dominated by grass and sedge, while closed canopy stands of good woodcock cover developed in low areas.

On the uncut check plot, heavy crown cover present in 1945 had declined in 1948 but had recovered somewhat in 1950. The stand appeared to be regenerating itself without treatment but, like the flood plain alder, did not attain optimum conditions as had occurred on treated stands.

In 1954, this series of plots was flooded by a beaver flowage to depths of up to 3 feet. Data could not be gathered that year and in later years all woody growth was dead.

(7) Clear-cutting in a 29-year-old gray birch stand on a gentle rocky slope produced dense reproduction. On the low, moist northeast corner of the plot, alder became the dominant species and produced a dense stand. Equally dense coniferous growth developed on the balance of the plot. Gray birch sprouts were abundant immediately after the cutting but declined to a very minor position after 5 years. It is believed that deer browsing was an important factor in the type of reproduction eventually produced because hardwood sprouts are heavily browsed while conifers are hardly touched. Also, removal of the overstory served to release well-established conifers in the understory. On the check plot, conifers eventually became dominant but their development was retarded by the hardwood canopy.

(8) Clear-cutting in a 26-year-old gray birch stand on a dry, level site with gravelly soil failed to produce a stand of reproduction in 11 years (through 1954). A good stand of hardwood sprouts was present the first 2 years. However, the refuge deer herd was approaching its peak at this time and the sprouts were heavily browsed. After 8 years, sweet fern dominated the plot. In 1954, conifers were slowly increasing in numbers and were expected to eventually cover the plot. The check plot varied little from the cut plot in cover type trends. Conifers developed a little more rapidly because none had been removed as on the cut plot.

The difference in cover development on the two clear-cut gray birch plots may be due to a difference in time elapsed since the areas had been burned. The first plot had not experienced fire in a number of years. Conifers were uniformly established and quite well developed on that area. The site of the second plot had been burned repeatedly for blueberry culture approximately 25 years earlier. Conifers were not as well established there.

(9) A plot was clear-cut in an unevenly stocked white cedar stand on a steep, rocky slope. The stand averaged 20 years of age. Five years after the cutting a fair stand of gray birch and

balsam was present on the lower half of the plot. A few dense clumps of cedar were present on the higher elevation but much of the intervening slopes was occupied by grasslands. The check plot had a more gentle slope and moist soil with spring seeps. The stand was a mixture of dense cedar, alder clumps, and grassland. These plots were not typical of the cedar type most commonly found on the Refuge. Data from them provide little information on whether clear-cutting in a normal cedar stand will produce good woodcock cover.

(10) Clear-cutting in a 49-year-old white spruce stand on a moist, level site with fair soil produced a fine stand of reproduction. On the higher side of the plot spruce and balsam dominated the stand, but the lower, poorly drained side produced a dense stand of alders. Growth on intermediate sections of the plot developed more slowly, with raspberry and meadowsweet dominant for several years. The check plot showed little change in 11 years. As the tall spruces matured and died, succeeding growth was spruce and balsam on higher parts of the plot and alder along the intermittent brook on the west side.

The forest study plots produced some general conclusions. The most significant of these is that ground moisture is a very important influence in the type and success of reproduction which follows clear-cutting. On low, moist sites alder was usually the dominant pioneering species. On dry sites coniferous growth became dominant in most cases, but the rate at which this growth appeared varied greatly. Often these sites support only sweet fern, meadowsweet, raspberry, or grassy cover for a number of years. Deer browsing is often a very important deterrent in attempts to establish hardwood reproduction. Very often luxuriant sprout growth following cutting was heavily browsed by deer and did not survive the second or third year.

B. Post-1950 Activities

1. Experimental projects.--In the early 1950's woodcock habitat work was confined to small experimental projects. Four of these projects as recorded in refuge narrative reports are reported upon:

(a) Discing young hardwoods.--In the fall of 1952 a 4-acre stand of young birch, aspen, and maple was worked over with a heavy brush disc drawn by a medium-size bulldozer. Trees, mostly in the 2- to 4-inch class (d.b.h.) with an occasional stem up to 6 inches, were bent over or broken off by the dozer. Trees were often uprooted but with the roots on one side remaining in the ground. The disc chopped up some of the smaller stems but left most of them intact.

The objective of this discing was to remove growth too old for woodcock and encourage new sprout growth. Examination of the area several years later revealed a dense stand of sweet fern with many interspersed pine seedlings but few hardwood sprouts. This later reverted to a nearly solid stand of pine having little value for woodcock.

The reason for the failure to produce sprout growth was not ascertained, but it should be noted that the treatment occurred 2 years before the first refuge deer herd reduction. With the overpopulation of deer, survival of hardwood sprouts was very low. On the other hand, soil disturbance by the dozer and disc provided an excellent germination bed for seed blown from nearby large pines.

(b) Plot cutting.--In early April of 1954 a 2-acre rectangular plot was clear-cut in a 30- to 40-year-old stand of birch-aspen-maple with scattered pines, spruces, and balsams. Soil ranged from dry and gravelly at the top of the slope to moist loam with pockets of organic material near the small brook at the lower end. Again, the objective was to remove overage hardwoods and encourage sprout growth. Cut material was dragged from the plot with a small crawler tractor.

Within 5 years the low moist part of the plot supported a good stand of alder. Much of this alder was of seedling origin; thus, the growth was slower than in sprout stands. However, in 10 years the cover had developed into good woodcock habitat. The drier end of the plot produced a few hardwoods, but not enough to form a closed canopy woodcock cover. The plot, however, served as a singing ground for some years and was still suitable for that purpose in 1973.

(c) Deer exclosures.--In 1954, four plots one chain by two chains in size were fenced to exclude deer. The objective was to test the influence of the refuge deer herd on establishment of hardwood reproduction. Snowshoe hares and other small mammals were not excluded. The plots were located in:

(1) the birch aspen stand that had been burned in the spring of 1950.

(2) an opening created by clear-cutting a birch-aspen-maple stand in 1944.

(3) an area of second-growth hardwood and conifers undisturbed in more than 20 years (established as a check plot).

(4) the clearing from a birch-aspen-maple stand clear-cut in the winter of 1953-54 (fenced a few months after cutting as opposed to (2) above where fencing was erected 10 years after cutting).

Shortly after these plots were established, the Refuge was opened to deer hunting for the first time in 17 years. After 1955, the herd had been reduced to normal level for a hunted area. Thus, the area surrounding the plots was subjected to heavier browsing than normal the first year but conditions were normal in later years.

The three treated plots showed the following results:

(1) On the burned area change was slow but seedling birch and aspen became established. After 5 years the seedlings had topped the sweet fern, producing a good stand of reproduction within the exclosure, whereas none could be seen on adjacent unfenced land. Seedling growth was slow and had not produced good woodcock cover 10 years after the exclosure was erected.

(2) On the area exposed to unrestricted deer browsing for 10 years following clearing there was practically no difference between cover within the exclosure and that outside. Overbrowsing had completely eliminated hardwood sprouts and only a few scrubby conifers were present.

(3) Where the exclosure was erected a few months after clear-cutting, the difference inside the exclosure was

quite striking. Sprout growth was luxuriant and formed a closed canopy cover in some spots suitable for woodcock habitat within 5 years of the cutting. In 10 years the entire plot was good woodcock cover. Outside the exclosure, browsing removed most of the hardwood sprouts and encouraged coniferous seedlings; that stand was almost pure conifers 10 years later.

Reproduction on the fenced check plot was slightly better than on the unfenced portion of the stand. However, this was a closed canopy stand offering no stimulation for the growth of either sprouts or seedlings. The difference within the exclosure was barely discernible.

These plots demonstrate two factors influencing reproduction of forest stands. First, deer browsing, even by a normal-size herd, can almost completely eliminate hardwood sprout growth in 2 to 3 years, thus preventing establishment of woodcock cover. Secondly, seedling stands of hardwoods develop much more slowly than sprout stands. This permits conifers to develop more rapidly, free of hardwood competition, if the area has not been recently burned to retard coniferous development.

(d) Experimental treatment of grassy birch stands.--In April 1957 an experimental block was established on the east side of a birch ridge to test results of different treatments on

birch stands with dense grassy ground cover. This was relatively young gray birch--up to 4 inches in diameter--in a poorly stocked stand. The open canopy encouraged a rank growth of grasses and sedges which prevented usage by woodcock except in early spring.

The block was divided into parallel adjoining strips one chain wide by two chains long. These strips were treated as follows:

Strip 1 - check plot
2 - broadcast burned
3 - clearcut, slash piled and burned
4 - clearcut, slash chipped
5 - clearcut, slash lopped and scattered
6 - clearcut, slash disced with brush disc
7 - wallowed down by bulldozer
8 - check plot

One-half of the entire area, that on the lower slope, was fenced to exclude deer.

Results of this experiment were inconclusive. Burning was conducted at a time when trees were not severely damaged; dead grass was removed but new growth in later years was not affected. Varying the slash treatment on the clearcut plots

did not change results. From strip 3 through strip 8 an increasing percentage up to half of each strip was on a level area at the foot of the slope. On that area a fair stand of alder developed from roots of a few decadent alders present in the birch stand. This was within the fenced area so the scattered birch clumps produced enough sprouts that, along with the alder, resulted in a respectable woodcock cover. On the slope, sprout clumps were scattered and much of the area produced dense grass the same as before the treatment. Outside the exclosure, sprout development was retarded by deer browsing. Possibly larger plots on more uniform terrain would show preferences among the types of treatment used.

2. Later plot cutting.--In 1956 a long-range cutting program with annual acreage allotments was initiated. This plan called for plots to be cut in areas where soil and moisture conditions were favorable for development of woodcock habitat. These areas usually included sections of valleys with intermittent brooks or were near brooks. Forest cover was mixed growth, sometimes with hardwoods or softwoods predominant in the overstory, with some alders in low spots. Existing growth was too old for woodcock habitat.

Plots were rectangular and 0.4 to 2.0 acres in size--most were 1.0 acre. This meant each plot included some dry knolls or rocky slopes which would never develop woodcock cover. However, scattered woody growth appeared very slowly on those spots and they were available for woodcock singing grounds for many years.

Treatment of these plots varied somewhat. Most were clearcut but frequently alders and small shrubs were left standing. On at least three plots, trees under 4 inches in diameter were cut while larger trees were girdled. Slash on most plots was left as it fell, but on some it was chipped or piled and burned. Merchantable pulpwood, logs, and fuelwood were sold, when possible, where they lay on the plot.

Funds were allotted for this work in Fiscal Years 1957, '58, and '59. However, much of the allotment was diverted to other uses in the 2 later years. In FY's 1960, '61, '62, and '67 a few plots were cut by use of regular refuge funds or by refuge personnel. In FY 1963 a small number were cut by a Public Works crew under a blanket allotment of work funds to the refuge.

In the following table of plots and acres cut, the dominant criterion is that of the crown cover; the few plots dominated by alder fell in the mixed growth category by virtue of scattered crown cover present.

| Year* | Hardwood Plots | Hardwood Acres | Conifer Plots | Conifer Acres | Mixed Plots | Mixed Acres | Total Plots | Total Acres |
|---|---|---|---|---|---|---|---|---|
| 1956 | 17 | 18.4 | 9 | 10.5 | 20 | 22.2 | 46 | 51.1 |
| 1957 | 9 | 9.0 | 8 | 8.5 | 6 | 6.0 | 23 | 23.5 |
| 1958 | 5 | 4.8 | - | - | 5 | 4.4 | 10 | 9.2 |
| 1959 | - | - | 1 | 0.5 | 2 | 2.0 | 3 | 2.5 |
| 1960 | 2 | 1.7 | 2 | 2.2 | - | - | 4 | 3.9 |
| 1961 | 3 | 3.0 | 2 | 1.5 | - | - | 5 | 4.5 |
| 1962 | 1 | 1.0 | 8 | 8.0 | - | - | 9 | 9.0 |
| 1966 | 5 | 5.0 | 1 | 1.0 | - | - | 6 | 6.0 |
| Total | 42 | 42.9 | 31 | 32.2 | 33 | 34.6 | 106 | 109.7 |

*Calendar year except a few were completed early the following year.

Clearcutting of plots produced variable results. When slash was chipped or burned a plot frequently was used by woodcock as a singing ground the first spring after cutting. Almost invariably, good stands of alder appeared in low moist spots. The exception was on saturated organic soil where sedges, sphagnum, and black spruce seedlings or layer sprouts dominated.

In some cases higher ground produced good stands of birch-aspen-maple sprouts but heavy deer browsing retarded development of hardwood stands. Often the land had not experienced fire in many years and conifers were dominant in the understory. Removal of the overstory released the conifers which soon were well on their way to dominating the stand.

The final measure of success or failure in producing summer woodcock habitat on the plots was the degree to which alder or aspen stands developed. That, in turn, depended upon moisture conditions. Moist sites usually produced good summer habitat--dry sites stayed open and were valuable primarily as singing grounds.

Deer exclosures 0.1 acre in size were erected on two plots where the pre-cutting stand was birch-aspen-maple. The refuge deer herd had been reduced to normal numbers by two consecutive hunting seasons (annual deer seasons occurred from 1954 through 1971). Even with a normal herd, the exclosure study showed that browsing on hardwood sprouts sharply curtailed development of sprout stands suitable for woodcock cover. The difference between sprout growth inside the exclosures and on adjacent area outside was pronounced.

3. Bulldozing standing timber.--In 1968 several tracts totaling 67 acres of standing timber were bulldozed to remove tree growth too old for woodcock cover. On one tract of about 5 acres the growth was mature aspen and white birch up to 12 inches in diameter (d.b.h.) on a dry site. Most tracts supported stands of conifers from which merchantable pulpwood was sold before the bulldozing, where possible.

This method of treating overage stands was an attempt to find a cheaper means than clearcutting. Although costs of both methods vary, it appears that bulldozing costs are about one-third those of clearcutting by 1956-66 procedures. However, after discounting space from

which the thin topsoil has been removed (where nothing will grow for many years), and that occupied by huge piles of debris, the available woodcock habitat is probably less than one-third that produced on the same size tract by clearcutting. Bulldozing has not yet been fully evaluated at Moosehorn as a means of creating woodcock habitat.

4. Alder clearcutting.-- In the winter of 1958 an alder stand was clearcut by use of a rotary brush cutter powered by a small caterpillar tractor. This cutter has revolving blades, similar to a lawnmower, which chop woody material into short pieces and scatter them over the land. It will cut shrubs and small trees up to 3 inches in diameter at the base. The stand ranged from well stocked and quite vigorous where it had spread over an old field, to scattered decadent stems in a sedge meadow near a brook.

Alder sprout growth developed rapidly after the treatment. A closed canopy formed over much of the area in 3 years, and in 5 years had reached peak development. Cover in the old-field part of the stand was actually too dense for good woodcock habitat. All ground cover was completely shaded out, leaving bare soil. Trapping studies at Moosehorn suggest that woodcock prefer light ground cover to bare soil. Alder clearcutting with a rotary cutter proved an effective and inexpensive method of regenerating decadent alder stands.

## SUMMARY

The American woodcock is an increasingly popular migratory game bird of eastern North America. The species was depleted by market hunting near the turn of the century and adverse weather caused population declines in this century. During the rapid expansion of the national wildlife refuge system in the late 1930's, one refuge, Moosehorn, was established primarily for the benefit of woodcock.

The history of Moosehorn National Wildlife Refuge in Maine reflects the waxing and waning support for measures designed to benefit this fine game species. Efforts there have centered on habitat manipulation, more specifically on removal of forest growth too mature for woodcock habitat, and encouragement of young, closed-canopy hardwood stands preferred by woodcock. Work has included a number of experimental management measures designed to provide information on the needs of woodcock and factors to be considered in improving conditions for the species.

Prior to 1950, most habitat manipulation was done by CCC and NYA crews under the direction of University of Maine and refuge personnel. After 1950, work was accomplished by refuge funds and personnel. Major accomplishments were:

1. Forty-eight singing grounds were created in unbroken forest cover which was good woodcock breeding cover but lacked openings.

Nearly all of these singing grounds were used; some were still in use 25 years later. Collectively they prolonged the useful life of the woodcock covers they served somewhat beyond that of untreated covers.

2. Approximately 250 acres in small blocks (mostly 0.4 acre) were clearcut with the slash piled and burned. On moist sites, good alder covers usually followed the cutting. A few poorly drained upland sites produced good stands of hardwoods, primarily aspen. Most upland sites developed coniferous cover over a period of 20 or more years. Hardwood sprouts on most sites were browsed to extinction in 2 to 3 years by a large deer herd. All plots served as singing grounds for as long as portions remained free of tree and shrub growth. An evaluation study of the major pre-1950 cuttings, including stumpage cuttings, was made by Jim D. Rearden, a University of Maine graduate student, from the fall of 1948 through the spring of 1950. He found substantially more usage by woodcock on improved areas than on the surrounding untreated areas. He concluded that cuttings, especially in lowlands, were decidedly beneficial to woodcock.

3. Eight large clearings totaling 68 acres were created in fire subclimax birch-aspen-spruce-balsam type. Hardwood sprouts on these openings were heavily browsed by deer and the areas remained open for many years. These areas were used as singing grounds and, as later discovered, for woodcock night roosting areas. Low moist sections produced good alder cover.

4. Clearings made by sale of stumpage generally produced the same results as clearings made specifically to improve woodcock cover. Frequently they were located on sites less desirable for woodcock and usage by that species in later years was correspondingly less.

5. Of 36 acres cleared by refuge personnel, 14 acres at Edmunds produced some of the finest woodcock habitat on the refuge. This was in poorly drained coniferous type where roots of decadent alders produced an excellent new stand of that species. Clearing on upland sites by refuge personnel produced openings useful primarily as singing grounds.

6. Spring burning on about 17 acres of birch-aspen type killed all trees and produced openings with blueberry-sweetfern ground cover. These served as singing grounds but their true value was not learned until Fant Martin studied the area in 1962. He found that large numbers of woodcock use these openings at night, presumably for roosting. Since then the burned areas have been very productive capture sites in the Moosehorn woodcock banding program.

7. From miscellaneous projects it was learned that earthworms are found in Moosehorn soils from pH 4.75 to 6.00. Eight or more earthworms per cubic foot of soil provide an adequate source of woodcock food. Alder seed planted on a plowed grass-sedge flood plain with heavy clay soil did not germinate--possibly due to excessive soil drying after sod cover was removed. Fall burning of blueberry fields was found to be impractical because of uncertain weather.

8. A series of forest study plots was established to determine the effects of cutting on various cover types. Ground moisture was found to be a very important factor in the type and success of reproduction following cutting. Low moist sites usually produced alder in a relatively short time. Drier sites usually produced coniferous growth but a number of years later than the alders appeared. Hardwood sprout growth was browsed to extinction by an abnormally large deer herd.

9. A young gray birch stand worked over with a bulldozer-drawn brush disc failed to produce woodcock habitat. Dry soil and heavy deer browsing eliminated hardwood sprouts and pine seedlings flourished on the scarified soil. The result was a nearly pure stand of pine.

10. Deer exclosure plots showed that (a) birch and aspen seedlings following a burn develop much more slowly than sprout growth following clearcutting; (b) an area exposed to unrestricted deer browsing for 10 years following clearcutting failed to develop hardwood reproduction, while a similar area from which deer were excluded produced excellent woodcock cover in 5 to 10 years.

11. Results on 106 plots totaling 110 acres clearcut in 1956 through 1966 were similar to those on plots clearcut in 1940-41. Good stands of alder cover were produced on low, moist areas, while upland areas slowly produced conifers. Even a normal-size deer herd may prevent sprout growth from developing into good woodcock habitat.

12. Clearcutting an alder stand by use of a tractor-drawn rotary brush cutter was very effective in establishing vigorous alder regeneration. On the younger old-field portion of the stand, the reproduction was actually too dense for good woodcock habitat.

General conclusions from the Moosehorn habitat studies are that most forest cover in that area is progressing from fire subclimax birch-aspen-maple type to climax spruce-balsam type. Birch-aspen-maple is good woodcock habitat, while spruce-balsam is not. Alders persist many years on low, moist sites but eventually that species, too, will be crowded out by conifers. Flood plain alders will be the last to go, and intermittent flooding of stream sections by beaver may perpetuate flood plain alders indefinitely.

These situations are not confined to Moosehorn. Rather, they are typical of much of Maine and possibly much of the northeastern United States. The habitat manipulation described in all cases attempts to reverse or retard type succession from good woodcock habitat to poor woodcock habitat. While such manipulations may not be feasible as broad-scale land use practice, they are valuable demonstrations of what can be done in special instances such as the need to maintain Moosehorn habitat for woodcock research. Also, they may suggest ways that general land use practices may be slightly altered to benefit woodcock at little expense to other objectives.

## RECOMMENDATIONS

A necessary prelude to any recommendations for future activities at Moosehorn is a consideration of the probable demands on the species, trends in conditions vitally affecting its future, and the status of available information for managing it.

Although comprehensive harvest data are lacking, the available incomplete data suggest that the woodcock harvest is increasing by about 10 percent per year. Approximately 0.5 million hunters now harvest about 1.5 million woodcock annually in the United States. Using more widely studied waterfowl as a basis for comparison, about 1.6 million hunters in woodcock hunting States harvest about 10 million waterfowl annually. It is evident that woodcock provide a substantial amount of recreation and the demand upon the species is rapidly increasing.

Data on the size of the woodcock population are lacking. There is no indication that the demands on the species are approaching its ability to meet those demands. However, waiting for a crisis to develop would constitute failure to meet responsibilities imposed upon the Bureau by law and by treaty. The woodcock's reproductive potential is low; a female produces but one clutch of four eggs annually. Recovery from a catastrophic population decline would be slow, necessitating drastic curtailment of woodcock hunting, a significant source of recreation.

The rate at which woodcock habitat is being lost through clearing for agriculture, housing, highways, and industrial development is cause for concern. The problem may be more acute on the wintering grounds, where the entire continental population is concentrated in a relatively small area. The trend toward increasing overseas shipments of grain will prompt increased land clearing for agriculture--a situation already serious enough to warrant intensive study. Human population expansion, forestry practices, and efficient forest fire control are reducing habitat on the vital breeding grounds as well.

The store of information on habitat as well as natural history of woodcock is pitifully inadequate to copy with growing problems of perpetuating this important resource. Moosehorn National Wildlife Refuge is the logical site for conducting woodcock studies, especially those involving breeding habitat. The Refuge was established for woodcock, and in its files is a backlog of data useful in those studies. At a time when demands on the species are increasing, it seems logical to increase rather than decrease the species' share of funds available for migratory bird research and management.

The quality and quantity of woodcock habitat at Moosehorn are declining at an accelerating rate. In the absence of fire, forest cover is reverting to the spruce-balsam climax type. That trend will continue in the absence of treatment known to be effective in reversing or retarding the trend. If it continues, woodcock habitat will eventually comprise only a minor portion of Moosehorn's total acreage.

It is recommended that a comprehensive program of cover treatment be initiated at the earliest possible date to renovate and maintain the present acreage of woodcock habitat at Moosehorn. The greater the delay, the more difficult the task and the greater the decline in value of recent studies.

It is further recommended that studies be conducted in conjunction with habitat treatment that will evaluate that work in terms of habitat required by various sex-age groups of woodcock during the spring, summer, and fall. This program would require a well-documented intensive trapping program to evaluate cover treatment. Captured birds should be banded and released to provide needed additional movement, migration, and homing data for the species. As a minimum, a program comparable to that at the peak of the woodcock banding program in 1963 to 1966 is needed.

It is recognized that the recommended program will be expensive--possibly exceeding the present fiscal allotment for Moosehorn National Wildlife Refuge. However, the expense would not be disproportionate to the need nor to the value derived from this bird in proportion to other migratory game birds. This should be a joint program, with participation by all organizational divisions of the Bureau concerned with woodcock.

## LIST OF PLANTS REFERRED TO IN TEXT*

| Common Name | Scientific Name |
|---|---|
| Sphagnum | *Sphagnum* sp. |
| Bracken fern | *Pteridium aquilinum* |
| Balsam | *Abies balsamea* |
| White spruce | *Picea glauca* |
| Red spruce | *Picea rubens* |
| Black spruce | *Picea mariana* |
| Tamarack | *Larix laricina* |
| White pine | *Pinus strobus* |
| Norway pine | *Pinus resinosa* |
| White cedar | *Thuja occidentalis* |
| Willow | *Salix* sp. |
| Quaking aspen | *Populus tremuloides* |
| Large-toothed aspen | *Populus grandidentata* |
| Sweet-fern | *Comptonia peregrina* |
| Gray birch | *Betula populifolia* |
| White birch | *Betula papyrifera* |
| Speckled alder | *Alnus rugosa* |
| Meadow-sweet | *Spiraea latifolia* |
| Raspberry | *Rubus idaeus* |
| Choke cherry | *Prunus virginiana* |
| Red maple | *Acer rubrum* |
| Blueberry | *Vaccinium angustifolium* (and closely related varieties) |
| Milkweed | *Asclepias* sp. |

*Nomenclature, except Sphagnum, follows that of Gray's Manual of Botony, Eighth (Centennial) Edition - Illustrated, American Book Co., 1950.